General Training On Methodologies For Geological Disposal in North America

IAEA Network of Centers of Excellence

Yucca Mountain Project Total System Performance Assessment Approach

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- Office of License Application & Strategy

Performance Assessment (PA) and Total System Performance Assessment (TSPA)

- PA: method for evaluation of system, subsystem or component performance
- TSPA: a system-level PA, subsystems and components are linked into a single analysis

Purposes of Performance Assessments

- Evaluate and demonstrate capability to model system and its components
- Understand system and components
- Account for and treat uncertainties
- Guide ongoing scientific investigations
- Address ability to meet safety standards

Limitations of Performance Assessment

- International consensus: performance assessment approach is appropriate for evaluating long term repository safety
- There are limitations:
  - Models are abstractions of reality
  - Projections carry significant uncertainty
  - Absolute validity cannot be determined
- Scientific basis work and model testing can provide adequate level of confidence

Construction of a TSPA: The Information-Flow Pyramid

- Design, laboratory, field, underground and other (e.g. analogue) information is compiled
- Features, events, and processes (FEPs) of potential importance are identified
- Conceptual models are created based on this information, visualizing how processes and components operate and interact

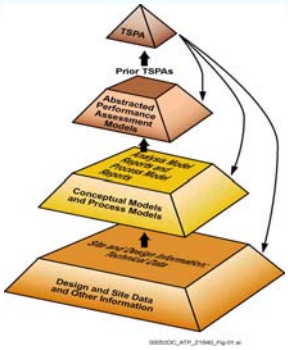
Construction of a TSPA: The Information-Flow Pyramid, Continued

- Conceptual models and data are synthesized into process-level models
- Process models may be linked to constitute detailed subsystem models
- Process and subsystem models are used to evaluate new data and determine data needs

Construction of a TSPA: The Information-Flow Pyramid, Continued

- Detailed models are “abstracted” to produce models that address critical performance-determining aspects, when appropriate
- Sensitivity and uncertainty studies verify appropriateness of abstractions
- Resulting models are linked to produce TSPA model

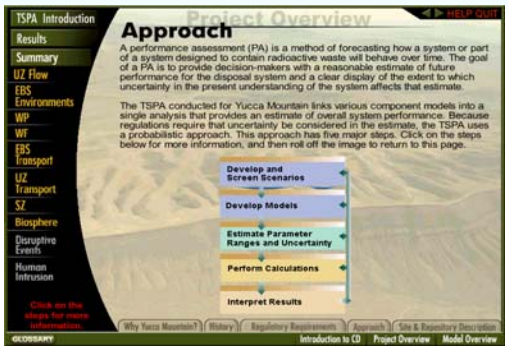
The TSPA Pyramid



A TSPA Is More Than a Model

- Performing a probabilistic TSPA requires data variability and ranges be described in probability distribution functions
- Initiating event probabilities are needed for scenario consequence analyses
- Uncertainty and sensitivity analyses are vital to interpreting or using results

Five Steps of Performance Assessment



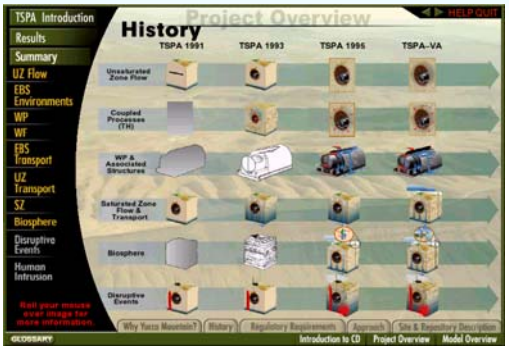
FEPs and Scenario Screening is Fundamental, A Lesson Learned

- The Yucca Mountain Project has developed a FEPs database
- The database is now appropriately comprehensive and auditable
- Lesson: Develop FEP list early in program and then continually update

DOE's Approach to TSPA Was Developed and Matured Over Many Years

- The first TSPA-like calculations were done in the early and mid-1980's
- The first official TSPA for the Yucca Mountain Project was done in 1991
- Tools, data and process understanding improved as TSPAs progressed

TSPA-SR is an Evolution of Previous TSPAs



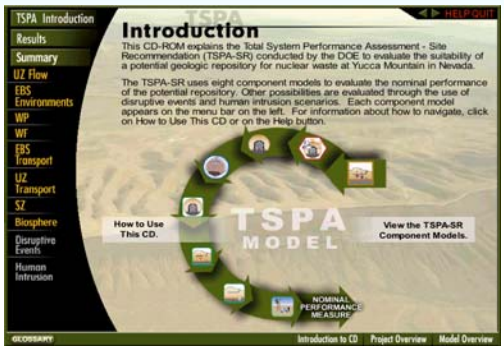
Purposes of TSPAs Changed Over Time

- The purpose or context of a TSPA is an important determinant of its scope/ approach, an example is DOE's TSPA:
  - 1980s: basic understanding of site function; implementability of proposed regulations
  - 1990s: develop TSPA capability; guide data collection; preliminary indications of safety
  - 2000s: demonstrate regulatory compliance

The TSPA-Site Recommendation (SR) Multimedia CD-ROM

- Illustrations in this presentation are from the TSPA-SR CD-ROM created for education & public information purposes
  - Its use is demonstrated in this presentation
  - A copy is provided for each participant

The TSPA-SR Multimedia CD



The Simplified TSPA is an Educational Tool

- Supports communication of TSPA to technical community, interested stakeholders, and the public
  - Part of a multimedia CD of the TSPA-SR
  - Runs quickly and on a personal computer with a processor rated at or above 400 MHz
  - Contains enough detail to represent and explain full model

Some Features of the Simplified TSPA Model

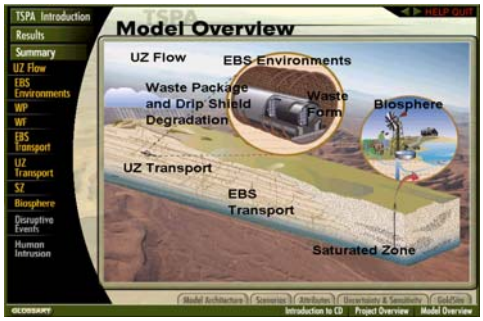
- Visual appeal
- Various levels of explanation
- User interactivity (GoldSim Player and Dashboard)
- Fully stochastic, although interactive model is a mean value simulation

Regulatory Requirements for Yucca Mountain

Example of Type of Information on CD-ROM

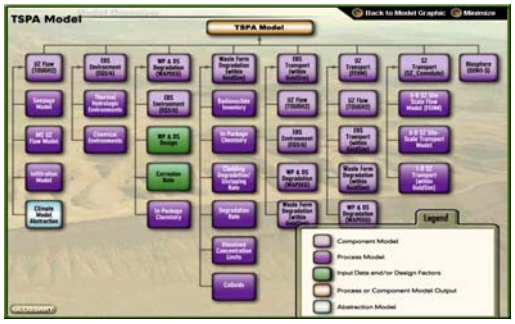
Overview of TSPA-SR Models

Example of Type of Information on CD-ROM



The TSPA-SR Model Hierarchy

Example of Type of Information on CD-ROM



A Schematic of the Sub-Models

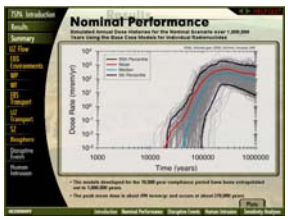
Example of Type of Information on CD-ROM

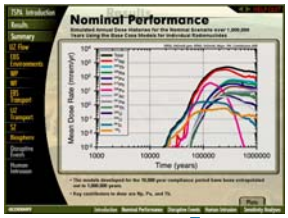
GoldSim is the Computer Program Used for Yucca Mountain TSPA Simulations

- Links dlls
- Stochastic
- Simulates Transport
- Flexible

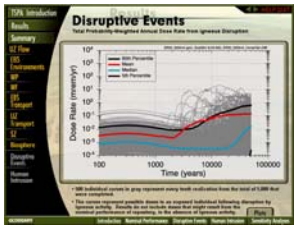
Types of Dose Results

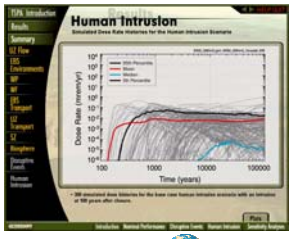
(Have Been Superseded By More Recent Calculations)



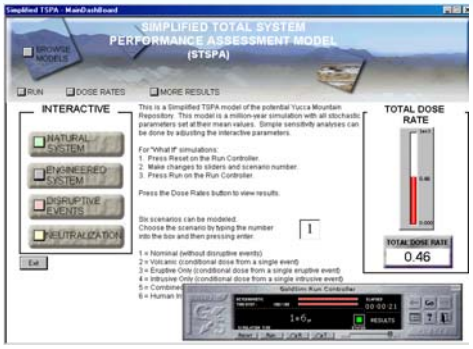


Disruptive Event and Human Intrusion Results
(Have Been Superseded By More Recent Calculations)

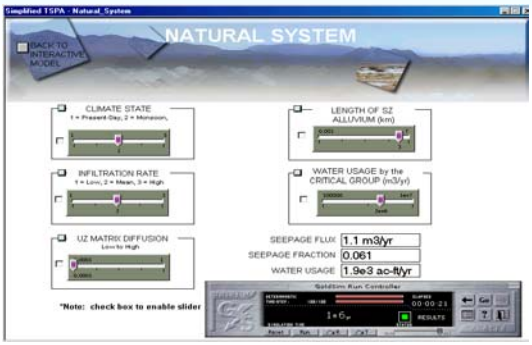




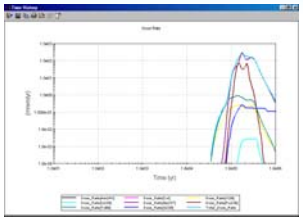
The Simplified TSPA

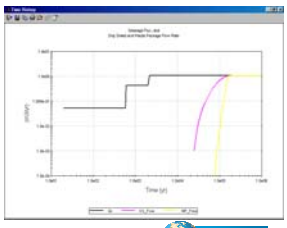


Examples of Sensitivity Studies

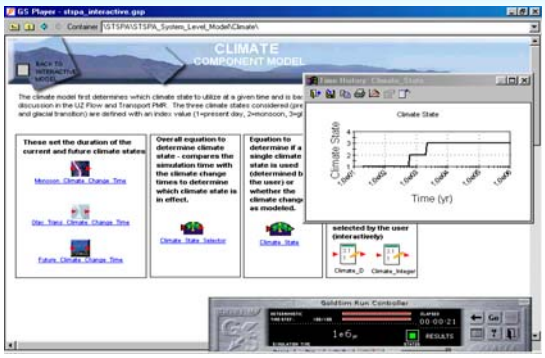


Examples of Simplified Model Results





GoldSim Representation of the Climate Model



GoldSim is Not the Only TSPA Tool

- GoldSim and its predecessor was a joint-venture between Golder Associates, Inc. and the DOE (Yucca Mountain Project), hence, it is simply our tool of choice
- This is not a DOE endorsement of GoldSim
- Other repository programs are using or developing their own, appropriate, TSPA tools